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INDEX-CONTENTS

	Page
Editorial	3
Question Box—Philadelphia Annual 1929, conducted by Geo. B. Hogaboom	4-23
Dr. Blum—Summary Bureau's Work	23-35
Pittsburgh Branch News	35-38
A. E. S. Page	36-37
Applications, Elections, Etc.	38-39
Directory	40

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VOL. XVI JULY, 1929 No. 7

EDITORIAL

Our Seventeenth Annual Convention has come and gone, and has added to the history of our society, both from standard of educational program and the social end of the convention, not forgetting plant visitation part of the program. Nowhere we may hold a convention holds so much in store for the observer who avails himself of the visits to plants as Detroit, and these committee men did themselves proud in their endeavors to assist visitors to see as much as the time would permit.

Did you know that 23 out of 24 papers read were read by chemists or chemically trained men and this in itself was highly commendable, and it is a sure omen that our society is keeping in progress with the time and demand of employers for more intelligent methods of plating control and research.

Of course it is hoped that we may not become to highly technical all at once and lose the interest of the member who is slowly but surely grasping the mechanics of chemistry in high schools and vocational schools of United States and Canada, or we may lose the interest of that part of our group of fellows who are always furnishing commercial efficiency that is necessary to further success of our education. I believe that our convention committees will do well to try and hold this matter in mind and greater interest in our future conventions will result.

THE EDITOR'S MEMOIRS

As the editor of your Review for past three fiscal years, I address you "I" rather than the editorial "We", for just this once, because this is a personal message.

I wish to thank every member of the American Electroplaters Society and the many associate members and subscribers to our Research Fund, for the timely aid and advice offered me during my different terms of office in your society—as Vice-President, Secretary-Treasurer, President and Editor—and assure you that it has been the privilege of a lifetime to associate with you and to serve you for another year.

As you all know, I was born long ago (I refuse to say when). My parents passed out of the picture when I was quite young, leaving me to support a family at age of 16 years. This was first imposition that was thrust upon me and, no doubt, is responsible for my dislike of large families and work.

Some children grow up, some are brought up, and many are dragged up by hard knocks and experiences, and summarizing my experiences, I guess I was in the class of dragged ups.

And although I feel that I passed the dangerous age of a growing kid, I am still hoping that I can fulfill my desire to keep the many associations and friendships formed while in service of A. E. S. and live to see the further progress of this great society.

F. J. Hanlon.

QUESTION BOX*

Conducted by Mr. Geo. B. Hogaboom, Past President A. E. S., Philadelphia 1929 Annual Meeting

MR. GEORGE B. HOGABOOM: Members of the Philadelphia Branch and Guests: I am a little bit surprised at Dr. Graham renigging and putting the time over on me, but inasmuch as the surprise was real (I happened to be with him at the time he received the program and I know that what he says is perfectly correct, that he did not have the opportunity of preparing anything) it is our misfortune.

When Mr. Gehling spoke to me and asked me if it would be possible to say something at this meeting, I consented, and later, in thinking over meetings that had been held, it occurred to me that probably a Question Box would be more in line than a set

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*Philadelphia Branch Annual Sov-Book.

speech. We have heard two very excellent speeches, one by Mr. Beaver and the other by Mr. Proctor, and they are very good. We need those; we need that work of investigation; we need the investigations to carry us along. But sometimes it is well to stop and think what has been done, to mull it over, and then to begin to ask questions. And it has been found in a number of the meetings that those present are kind of hesitant in asking questions other than those which bear upon the subject in hand. So, if you have a general, open question box, why, then any question is in order.

I had the privilege of speaking a week ago last night at the Bridgeport Branch, and tried the same thing, a Question Box, with more success, and it was very pleasing to note the large number of people that turned out. And for two hours straight, there was a continuous bombardment of questions. And what was the best part of it, and what pleased me more than anything else and made me feel it was worthwhile was that those in the audience took part and answered backward and forward. So that I would ask that same thing this afternoon, if the questions are asked, that those in the audience that have some answer on that question do not hesitate a moment, but give your views.

It must not be assumed, it cannot be assumed, that every question that comes up, a speaker can answer. That would be an impossibility. But you can give a general indication, and it is quite probable that there is someone in the audience that has enough experience in that line, in which the question is asked, to answer the question. So will you please do that?

Now I am going to take the privilege, if I may, of asking the first question. I think that is the speaker's privilege, and the question that I would like to ask need not be answered if you don't wish to but still I would like to ask it; and that is what causes nickel to peel when chromium plated, and how are you going to stop it? (Laughter.)

MR. CHARLES PROCTOR: I think Dr. Blum answered that question some time ago, when he said there is one thing chromium can teach us, to put a good nickel deposit upon the basic surface, and then chromium would not peel off. Of course, it isn't always in the cleaning. We sometimes go back at cleaning and think it is the fault of the cleaning. But I think it is right there in the nickel solution.

MR. HOGABOOM: Well, we will discuss that fully a little later on, and I may take issue with that statement.

Now, let us go along to general things and come to that afterwards. Has anybody a question?

MR. ALBERT HIRSCH: Could one add too much sodium perborate to a nickel solution?

DR. BLUM: I think Mr. Proctor probably has some information on that.

MR. PROCTOR: I think too much can be added. Too much of anything can be added.

MR. HOGABOOM: What would be the harmful effect of an increase?

MR. PROCTOR: It seems to me the effects are the reverse, when you have too much. When you add sodium perborate you have to acidate that sodium perborate, irrespective of the amount of it you use, to the acidity of your nickel solution. If you start putting it in your solution, it acts the same as any other alkali would act, and you get a reverse action of your solution. But when they put the correct amount in there, not only put it when it is absolutely needed, then, of course, sodium perborate does do the work—but I believe you can add too much. In fact, I have added too much myself, and got reverse results.

MR. HIRSCH: Will sodium perborate positively stop pitting?

MR. HOGABOOM: I don't think that question can be answered by "yes" or "no." You know that is one of those questions like a man that has said every question can be answered by "yes" or "no," and a fellow asked him if he had stopped beating his wife. If he says "no," it means he has been beating her, and if he says "yes," it means the same thing. You can't answer "yes" or "no" to every question. Pitting is not the result of any one thing, and, therefore, one thing will not correct pitting. Pitting can be from several causes. It can be from an excess of acid. It can be from probably organic matter in the solution. It can be from a high copper content in the solution. It can be that if you will clean work in a solution or in an alkali that has highly insoluble material in it, such as sodium aluminum silicate, and that adheres to the work, and that is not put through an acid so as to remove it; it is not thoroughly removed. That will cause pitting.

Pitting is of two kinds. If you will examine them under a microscope you will see that immediately. I am sorry we haven't a blackboard. A meeting without a blackboard is like a piece of steak without salt, almost. If you will examine pitting under a microscope, you will find if it is gas pitting, that the deposit will be like this:

DRAWS DIAGRAM

and there will be the bubble of gas in the centre. But the deposit will always come down, slope toward the pit. If it comes from some material on the work, for example, like sodium aluminum of silicate, the plate will try to bridge across that and it will slope up over the top, and then, if you wash that out and examine it, it will look like the crater of a volcano

DRAWS DIAGRAM.

I have some excellent micrographs of both classes of pitting—so that when you say pitting, you are using a general term that cannot be specified as it can be stopped by any one thing.

Now another cause of pitting, and I was very much interested in this pitting—it was brand new to me, only a few weeks ago; it was in the latter part of September. And that was plating on aluminum, where you nickel plate on aluminum, according to Mr. Harold Work's process. The percolators were made from aluminum. I had never in all my life seen such an elegant example of pitting. The whole article was one mass of pits. The whole trouble was low current density. Contrary to everything that would be expected, it was low current density. And in all probability what happened was—I may be wrong, I will ask Dr. Blum or Dr. Graham, or somebody to correct me if I am in error—but in all probability what happened was the nickel which was on there was so porous that it went on there like lace, and it was probably an electrolytic action that was setup between the nickel and the aluminum and caused a gassing which resulted in a pit. Now the example of it was this: There were twelve percolators put in a nickel solution, and the current density amounted to about two amperes per square foot. Beautiful pitting. The percolators were taken out, and three were put in, because the carrying capacity of the wire was not sufficient to carry enough current so you could get about eight or ten amperes per square foot. So they took out enough work to carry eight or ten amperes per square foot, ran the work for forty-five minutes, and not a solitary pit could be found. That was operated all day Sunday (I work on Sunday once in a while—not in Philadelphia, though; there is nothing open in Philadelphia on Sunday; it is dead)—we operated it all day Sunday and all day Monday, and later, one of our service men went down to that same plant and stayed there for ten days, and the thing was operated at ten amperes per square foot, and not a pit.

So, when you say pitting, it is your local problem, and you must try several remedies before overcoming it.

MR. ALBERT HIRSCH: I realize that. What I have reference to starts at the bottom of the rack—only the ones on the bottom are pitted, and I have used sodium perborate in various ways.

MR. HOGABOOM: I have cleared up pitting by cleaning anodes. I think dirty anodes is one of the greatest contributory causes toward pitting. It may be this. I have spoken for a long time upon the voltage that is used. I realize that in those days I didn't know what I was talking about. I should have said "anode current density," and now we will talk anode current density, and that is something that should be written on, because you have to have anode current density the same as your cathode current density. If you have a relation of your anode to your cathode so you can get anode current density so that you can get a cathode current density that will give you probably what you wish at a pressure of 1.8 volts, you get a very good nickel, without gassing, and without pitting. If you were to plate cast iron shears (Mr. Clark will bear me out) and you would want to grind those shears and sharpen them after they were nickel plated, you would not run over 1.8 or 2.0 volts at the outside, pressure. That is, you would have your anode current density so that you could get that. If you will do that, then you can grind and you can sharpen and not lose a shear. If you use more than that, say 3.0 or 3.5 or 4.0 volts, unless you are well protected, you get both pitting and peeling.

Now if you have an anode that is coated over, like the lower purity anodes, or solutions that are not run correctly, you get a polarization, that is, you get a blocking up of your current. When you get a blocking up of your current, and you want a certain number of amperes on your rheostat, you jack up your current. When you jack up your current, you increase that pressure. When you increase the pressure, it may be that you take and get a decomposition of solution. We watched, on the plating of metal; we watched for a small, brown spot that would appear on nickel plated work. The moment that brown spot appeared, we knew that within 24 hours we would have pitting. If we stopped at the first indication of that brown spot, cleaned our anodes, didn't change the solution at all, we wouldn't have any pitting. Then we could get our current density at a pressure that wasn't above the decomposition voltage of the solution.

Now, anode current density. If you have a square foot of

anode and a square foot of cathode in a nickel solution, for example, and that anode is clean, you can get five amperes per square foot, for example, we will say at 1.8 volts pressure. You have got, then, five amperes anode current density and five amperes cathode current density. You change the anode area so you have only a half of a square foot of anode area, and maintain one square foot of cathode area. You want five amperes per square foot on your cathode. You have got to have ten amperes on your anode. Now if you get that at 1.8 volts, when you have five amperes current density at your anode, you don't get it when you have to have ten. You have got to increase your pressure to get that across. When you increase your pressure and get that, then something happens in the solution.

Now on the opposite side, suppose you take a cathode current density of five amperes per square foot on a square foot of surface, and have two square feet of anode, then all you require is 2½ amperes on your anode per square foot. Then, instead of 1.8 volts, you may have to go down to 1.3, or even a lower voltage, to take and get that across. Now that may be a condition in which you do not get good anode corrosion, that your metal won't go into solution. In experimental work that I did on silver, back several years ago, I did that and gave a talk before the Platers' Society—I think it was in 1909, and I called it pressure, not knowing the term, "anode current density," at that time. When I had one-half volt pressure on my anode, that is, keeping my cathode area constant, and wanting five amperes per square foot, when I increased my anode area so I could get that five amperes per square foot on my cathode at half a volt pressure in a run of twenty-four hours a day, seven days in the week, I did not get any metal into my solution from my anodes. My metal constantly decreased. My anodes looked like galvanized iron. When I used a pressure of 1 volt, I got an upkeep of my solution. Mesle probably will take issue with me—we will ask Mesle in a moment because this is question box time. But that was my experience, that when we dropped to three volts, we got a black coating on the anode, and the meter immediately began to go down, because the anode was polarized. Had you said polarization to me, that day, I would have thought you were talking about the North Pole or the South Pole; but you get anode polarization. It is blocked off. That block would completely cover the anode, fall off, and then the ampere needle would return. Correcting that wasn't a very easy job. It

was analyzed and found to be silver peroxide, and silver peroxide is not as soluble in the cyanide solution as when it would go in from a clean anode—that is when the silver would go in from a clean anode, so that you there got a disintegration of your anode.

And so anode current density, in my opinion, plays a very important part, both in the upkeep of the metal in the solution, and the nature of the corrosion of the anode, and in all probability an effect upon the solution which in turn will affect the character of the deposit.

MR. F. C. MESLE (Oneida Community): I think that my experience in general is in accord with what you have said, Mr. Hogaboom.

MR. HOGABOOM: For the first time we agree.

MR. MESLE: We do agree, once in awhile. Just one thought that did occur to me. That is that sometimes, for instance, the position of anode to cathode will really give you a higher anode current density at certain parts of the anode than you think you have because maybe here is the anode (shows) and the cathode is down there (shows) and you will judge that your anode current density is at a certain point, when in reality most of the current is flowing from the lower third of the anode, and that, of course, causes the same trouble.

MR. HOGABOOM: Mr. Mesle, at the Hartford meeting of the Platers' Society, and later at Toronto, brought out one of the most important things there is in electroplating of recent times. The more I have thought over it, the more I admire his work, and the more appreciative I am of being able to listen to him. Carrying along what he has stated there, about the anode, he talked about cathode current density, and that is one of the misleading things, and why some fellows are misled by measuring with the micrometer and saying they are plating a thousandth of an inch of nickel in an hour. There is local cathode current density. You have here, for example, a piece of work, and Mesle found that in a spoon, for example, if this happens to be the bowl of a spoon (shows)—he may have outside here, on the outside edge, as high a local current density or current concentration there as 30 amperes per square foot. In the centre, he may not have over 4 or 5 amperes per square foot; but the total current density over the whole article would be 15 amperes per square foot, and you would say, "I am using 15 amperes per square foot," but where is that 15 amperes per square foot? You don't know. Now along comes a fel-

low and he uses a micrometer, he takes the edge, here, and he has got here, not fifteen amperes per square foot, but over here at the edge he has got probably what Mesle found, twice that, 30 amperes per square foot. Then he measures that and says, "I am using so many amperes and I get such a thickness, therefore, I am depositing a thousandth of an inch in an hour." He is wrong. This thing of distribution of current, as Mesle found, is very interesting, and it explains a great number of things, which I didn't understand myself before Mesle brought that out. I had a general opinion of it on account of some work on distribution of deposit of paper that I read in the Indianapolis Convention several years ago, but Mesle had the right thing; he gave the right definition of having local current densities or current concentrations at different points.

Now comes this point: If Mesle could get on the edge of the spoon a silver deposit that would be where it is perfectly O. K. for burnishing, at that edge, then it stands to reason that if you could get that all over that spoon, the same current density, then you could use 30 amperes per sqare foot all over the spoon. See what that would mean? We are plating today, five amperes per square foot average in the general plating shops. Mesle is doing better, by controlling it. That is six times faster than we can do today, if we learn how to distribute our current all over the surface so we get a uniformity, and that is what you want to consider when you are doing plating, that you are not getting the anode current density which your ammeter is indicating, all over your surface; you are getting local current densities.

MR. LEROY BEAVER: May I ask a question? The answer to it probably deserves a great deal of research on the part of the American Electro-Platers' Society. This is the problem. In the United States we have several hundred manufacturers of valves, and among their line they have what we call a ball seat, or a ball check valve. Now these balls used in some of the valves are chrome steel, sometimes they use brass, sometimes bronze, sometimes monel metal, and lately they have been using stainless steel. There isn't a week goes by that I don't find in my mail a letter from one of these valve manufacturers asking, "Can you supply us with chromium plated steel balls?" We find a bronze ball is not satisfactory due to the solutions carried through the pipes to which the valves are attached. Live steam affects an ordinary chrome ball. Monel metal is subject to disintegration; stainless steel, un-

less it is highly polished, isn't stainless. If the American Electro-Platers' Society, or some members of it, can work out some way to chromium plate a steel ball in such a way that the pounding of the ball on the seat will not break the chromium off, it is a question of thousands of dollars' worth of plating business waiting for them to take hold of. I have asked, recently, nine different platers in Philadelphia, and they have said, without exception, it can't be done.

MR. HOGABOOM: You have brought up a very interesting point, Mr. Beaver, and one that I think the Electro-Platers' Society should take cognizance of, because a large number of manufacturers that would be directly benefited, financially benefited by such a research are asking their platers to do it and are not contributing anything towards research themselves. It would be far better if they would contribute money or get a fund and establish a research fellowship, if they would take, and some of them have spent thousands of dollars,—take a portion of that money and support a fellowship at the Bureau of Standards it would probably solve that problem for them.

MR. BEAVER: The porblem is one that should be solved, because new concerns who are making valves are coming into the field all the time and asking: "What can you do for us in the way of chromium plating?"

MR. HOGABOOM: The question you want answered is how to wire a ball?

MR. BEAVER: I will tell you how we do it. I took a piece of half-inch pipe, used as a mandrel, and wrapped around that a coil of copper wire. I took that coil of wire off, and dropped down inside of it a half-inch steel ball, and on top of that ball a half-inch glass marble, and then another ball, alternating balls, and marbles until I had this coil full. Then I took it over to Harry Farland and said, "Harry, here is something I want you to chromium plate." He looked at me and used the customary platers' language to me, telling me it couldn't be done. I said, "Harry, will you try it, anyhow?" He said, "all right, we will give it a shot of acid copper and finish that with nickel, and then stick it in the chromium and see what happens." What happened was the ball came out chromium plated.

Then, everyone has been telling me how hard chromium is to polish, the only thing you could use is a green rouge or something like that. I took one of these balls, and on the carpet in the floor of my office I rubbed it back and forth a dozen times, using con-

siderable pressure, and got a beautiful polish. How do you account for that?

MR. HOGABOOM: Chromium is not difficult to polish. It can be steel ball burnished, providing the chromium is put on in a certain way. You, of course, must realize that you can get everything from a soft chromium deposit to a glass hard chromium deposit by regulating the current density and the temperature.

MR. BEAVER: I don't know what sort of an operation it was, or what the solution was, or anything; all I know is that the balls we polished have that peculiar bluish cast to them. But that is a way to do it; but it seems to me to be too intricate and involves too much intermediate handling. But I do feel satisfied that if there is an answer to that question, if some solution can be found of it, it is going to mean an awful lot of work for electro-platers all over the country, and you can get an idea when I tell you that a 5/8" steel ball satisfactory for valve requirements can be gotten from any of the foremost ball manufacturers at $16.00 a thousand, but if you want a stainless steel ball, in the equivalent of 5/8" size, you will pay $78.00. There is a terrific lee-way in it that the plater could charge a fee for his plating work on these balls that would substantially compensate him for the work, because if it is true that chromium is more resistant to many corroding agents than other metals at present use, there is no reason it shouldn't be applied to this particular use. It is one of those problems where a fellow says it can't be done, but it is going to be done; it is just a question who will do it first.

DR. A. K. GRAHAM: There is a member of the Bridgeport Branch (some of you know him) Mr. Seifert. Mr. Seifert had a steel ball he chromium plated, and he used a magnet to hold the thing in solution and change the position of the ball in order to chromium plate it where it was touching the contact. Now I am merely giving you what one of your men has already done. There is no reason why you should have to operate an individual magnet for each ball you put in, but a ball can be held in the solution that way, and changing the position of the ball where it is being plated. Now if you have to have protection on a steel ball, in some of those applications the balls could be given a cyanide copper or brass deposit, and then treated that way, because the steel in there would act as a core and still could be used. It is only a suggestion, but it happens to have been done.

DR. WM. BLUM: It works. Graham beat me to it. We

have done that, just in a purely experimental way. We wanted to make some tests of the friction coefficient of friction on some ball bearings. They wanted them chromium plated. We did it. I won't say as to whether it can be done—at least how practically it could be done, or how expensive it would be to do it, but we used a magnet for it just as Graham has said, put two or three of those on a magnet, a plain magnet or electro-magnet, and every few minutes just rolled them around there so as to get a different point of contact, and the deposits were fairly bright. Of course, they were probably not quite uniform.

The question struck me (which is more important than that) —how many platers have ever used a magnetic rack for plating? It is one of those things which you think of, that comes into your mind every once in a while. It was in mine for years, until this problem of these balls for chromium plating came up, and I never went to the trouble of trying it. And it worked. Now I can see possibilities in that, not only for chromium plating steel balls, but for other things where you may be able to use a magnet for a rack, in that way being able to plate articles where it is not feasible to attach wires to them—not necessarily steel balls, but other articles. While we haven't made any research or anything of the sort to find out whether it was commercially practicable, I can say with certainty you can plate steel balls if you hold them with a magnet and change the position occasionally.

MR. PROCTOR: I would like to say a word in favor of the use of the magnet. If any of you gentlemen go to Indianapolis, go to the Climax Machinery Company some time and see our friend, Mr. Hennessey. They are using magnets, four rows of magnets. They use horseshoe magnets and put them on a square cathode bar, and use it on articles that they can't frame up easily, like a ball. The tank is about six feet long. The man goes along putting the articles on the magnets, and the whole thing is put in the tank. The product is cleaned in the solution. They go down and he puts another row on. When that comes up, he has rubber gloves on, and he takes them off the magnets. That shows the possibility of the use of magnets in plating many articles. I saw screws plated that way. They had a basket for catching any screws that might fall down. They were plating screws that way, and some of them were nearly as good as those screws I showed you this afternoon, but, of course, you get, once in a while, a place where the deposit doesn't go in. But it shows the possibilities of using a magnet in chromium plating.

MR. HOGABOOM: I think the Question Box has been justified by bringing up a new point like that. Now in a general meeting, probably that point would have been brought up. Now we have learned something. Next question.

MR. PHILIP SIEVERING: Will you give a description of different dynamos used in chromium plating? 3 and 4 wire system?

MR. HOGABOOM: In generators, we have a disadvantage in that, but I will accept the challenge, although as an engineer, I dislike very much to recommend any specific generator. But in my opinion, the four-wire system is the only generator to use for chromium plating, for this reason. If you have a three-wire system generator, you could get twelve volts between the two outside poles, you could get six volts between the neutral and either of the outside poles. If you have, for example, a 2,000 amperes, 12-volt generator, between the outside poles you could get 1,000 amperes at 12 volts; on either pole, on either commutator,—you can get six volts at 1,000 amperes.

Suppose you are called upon to do chromium plating below six volts. You only can put your field rheostat down so you could get from the 12 volts probably down to 6 volts, and then you have got to take and use a tank rheostat to bring it below 6 volts, or else use one leg of your line, that is, one armature. If you plate on the one armature, then you get an unbalanced field and get a sparkling.

Now with the four-wire system, you can get the three-wire system, that is, you can get your 12 volts at your 1,000 amperes, but if you connect your two positives and two negatives by another switch, then you get two wires and you can get your full 2,000 at 6 volts. That gives you, then, a range from 2 volts (because on your field rheostat you can get down to 2 volts on a 6-volt generator. Then you can get 12 volts by turning it the other way, so you have got a complete range there of from 2 to 12 volts. Then, any good generator will stand a 25 per cent overload for a certain length of time, and that will give you 15 volts if it is necessary. So you have got a complete range, on a four-wire system, from 2 to 15 volts, which you cannot get in any other way.

Now, what voltage should you use for chromium plating? A great deal depends upon your solution. Mr. Sievering and a number of others are using 4, 4½ and 5 volts. They are using below 6 volts. Others are using 7, 8 and 9, and I have actually

seen 12 volts being used on chromium plating. That is a question of solution.

I would like to make just one more statement, and I don't want to be misunderstood as criticizing anyone. It is just about the effect of iron in solution. The way that iron will go mostly into solution will be through an anode of either using a steel anode or through a steel tank, or through using a thorough chromium anode. Some experiments were made, and you can duplicate them. Take a little glass battery jar, put in it hot water, and say you have four inches distance between the anode and the cathode, and you take an anode area and cathode area of equal size. You get in a solution that has no iron in it, you can get at four inches square, at 5 volts, 13 amperes. Put iron in that solution, and it doesn't require much before your amperage is only 3½, at 5 volts. Iron has a distinct property of increasing the resistivity of the solution, so that you have to use more pressure, and those that are being successful—I will not say that you cannot get successful plating by having iron in your solution; you can get successful plating by having iron in the solution, but the amount of pressure, the amount of juice that you are using and your cost, is considerably more than one without iron. In a problem which came to my attention, plating 2,000 bumper bar sets every eight hours, which meant four bumper bars, that is, two front bumper bars and four bumperettes, and plating not 20,000, but 2,000 a day for a whole year, with 300 working days a year, 2,000 a day, is quite a few bumpers and not one piece was lost but they had iron in their solution and they were getting 1900 amperes upon that amount of bumper bars with 12 volts. They changed the solution, using a solution free from iron, and the same load, and they got 150 amperes more, that is, 2,050 amperes, at 6¾ volts. That shows the effect of iron in the solution. They did get good plate with iron, absolutely good plate, but look at the cost of their power.

MR. CHARLES PROCTOR: I might answer and say that nevertheless, if you go into the Middle West I think you will find that iron is being used quite extensively in the solution. And they don't have to use 12 volts to plate chromium, or 9 or 8 or 7, because they can use less than 6.

MR. HOGABOOM: Iron, added as a chemical, precipitates. Iron will go into solution from an oxide. The only way to get iron in a chromium solution is to use an iron anode and run it in like you do in a porous cup. That is the way you will get iron in a chromium solution.

I might say this, that taking again the privilege of speaking, not as an engineer, or not as a representative of any house, but chromium plating is being done on a full automatic machine. One of the largest radiator shell companies, one of the largest automobile companies, are going to have a brass radiator shell on their automobile, which was exhibited for the first time yesterday in New York City. That radiator shell is buffed on an automatic buffing machine, hung on a rack, cleaned, nickel plated, bright nickel plated, and chromium plated, and comes out ready to put on the car, 320 radiator shells an hour,—full automatic. There is another installation where the bumper bars are going to be plated full automatic. Gears are being plated in chromium solution, full automatic, and that means that you just take the work and hang it on a rack with all its dirt and everything, and it goes through nickel and goes around through the whole thing and comes out without the hands touching it. The pieces work in and out, and chromium plating is being successfully done on full automatic, and with loose contacts, not positive contacts, not soldered contacts, just merely hang it on racks. So chromium is going along all right.

MR. CLARK: I had some experience with chromium, and, taking two solutions, one with iron and one without iron, I believe the one with iron is more to be adapted to articles that are perfectly flat, while for anything with a background another solution should be used.

Here is an article made of steel (shows) and I plated those with the iron solution. I found out they wouldn't plate in the crevices, those three crevices in there. I put them through the copper sulphate test, and immediately the copper showed me that there was no chromium on there. We had other articles which were flat, and they covered thoroughly. I put them through the copper sulphate test, and there was no copper at all. And I had to use another solution for this type of article, which you can see right here is plated in deep crevices, in all three corners, and has been through the acid copper dip. I believe a flat surface can be plated with the iron solution.

MR. HOGABOOM: Another point about the chromium solution I think would be of interest is that it isn't always necessary to have an anode shaped to the cathode, as has generally been done. In this full automatic on radiator shells, the shells are run lengthwise through the solution—there is an anode on either side, just exactly as in your nickel bath, and the wide radiator shell and the

bottom—it is plated upside down, and plates under the bottom, plates on the side, and there are just the anodes on the sides, and you don't have to take and put a special anode around it or anything. It plates right straight across. I think we have all been afraid of chromium, that is the trouble.

DR. A. K. GRAHAM: I wanted to comment on Mr. Clark's remark. It points out something that we know. In a solution that builds up in chromic salts, where your chromic acid content accumulates, the resistance of your solution increases, and consequently you have to use higher voltage for higher current density. The work of the Bureau of Standards has shown the resistance is one factor which influences throwing power. If you are plating a flat surface, there is not much difficulty in throwing; it is just current distribution over a flat surface. If the surface is recessed, then you are concerned with throwing power, and the solution which has higher throwing power would give you, in general better covering of a recessed surface. The similarity between chromium, chromic acid, chromic salt, and iron salt, is that they all increase the resistance of your solution, and they can be considered alike, and in that way would have the same effect.

MR. ROCKY MASSACOTTE: I was going to ask if your solutions are automatically agitated in any way.

MR. HOGABOOM: Convex current from the heat is quite sufficient to agitate it. There is no agitation whatever in the chromium solution.

MR. MASSACOTTE: I did a copper kettle, a water kettle, in chromium, and I had an awful time to convince the wife the inside was all right because the chromium got in it, and I said the agitation did that, and the inside was like tin, almost plated.

MR. CHARLES PROCTOR: That tank you have reference to, of course I am very familiar with the name of that plant. Did you say they are chromium plating direct on the brass?

MR. HOGABOOM: Nickel plated and chromium plated.

MR. PROCTOR: When I was in that vicinity a few days ago, they apparently were having trouble. They were copper plating the brass first before putting on the chromium.

MR. HOGABOOM: Was that due to trouble?

MR. PROCTOR: I don't know anything about the trouble.

MR. HOGABOOM: You said it was due to trouble.

MR. PROCTOR: I said they said there was trouble in the plant and they were copper plating the brass first.

MR. HOGABOOM: That is generally the way some people observe things; they only observe half and only tell half the story. The thing is to tell the whole story, and then you are not misunderstood. It has been known for a long time, there has been plenty of work published—Ollard has published some in England, and there has been some published in this country—the two Grant Brothers published some very excellent papers upon it, and found that where brass is directly chromium plated that there is a tendency—now not on all brass, because remember a thing that looks like brass may not be brass; brass is an alloy of copper and zinc, and when you say brass you must designate what alloy it is. Scovill Manufacturing Co. manufacture brass in 100 different alloys. So that when you say brass, be sure you know what alloy is being used. Common high brass containing 65 per cent copper and 35 per cent zinc, or a brass containing a high zinc, it has been found as a rule, especially on flat surfaces, plain surfaces, and other surfaces, that there are cracks develop in chromium, hair line cracks. Baker has noticed them, and as I told you, the Grant Brothers and Ollard, and the Bureau of Standards and a number of platers have also noticed them. In the experimental work on this particular job, it was found that chromium plated over copper did not exhibit those cracks even after a long exposure. They did not exhibit those cracks. It was found also that if you nickel plated directly upon brass and put a light nickel plate on, you got a porous deposit of nickel, naturally. All you have to do is to take some litmus paper and put it across clean nickel plated brass, and you will get the brown spots from ferri-cyanide from off the copper, ferride-copper, rather. You will get the brown spots showing there is porosity. When you chromium plate over a thin coating of brass and have a porous deposit of nickel, and let it stand, you could see, under a microscope, a beginning of that crack where those pores were. We saw them, but they began under that. Well, then, it was assumed, as was argued between us, that if we would copper flash the brass we would overcome that. The brass was copper flashed, and not a solitary crack appeared. None have yet appeared, and it has been several months, and any brass that was copper flashed, it has stood up perfectly.

Now, in speaking about that to two different men that are doing considerable chromium plating, one in Bridgeport and one that is a member of your branch here, and in Bridgeport the man got up and he stated, "I had ten pieces of work to do. One piece,

I did over ten times, and could not plate it; I could not make the chromium adhere. I got cracks, and it would come off. I flash coppered that, put that through, and it would adhere perfectly." The other day I had the privilege of visiting a man that is an expert in chromium plating, and in speaking about that he said the very same thing; he said he had a number of pieces to do, and he plated them, and there were some pieces that would not take and cover. He flash coppered them and immediately they covered. He said it was so apparent that they were better that he turned around and stripped the other pieces that were evidently successful and then copper plated and chromium plated them, and he had no trouble at all, and every piece was perfect.

So that it is quite evident that if you copper plate brass, give it a flash copper plate before you nickel plate it, that you will have less trouble on those hair line cracks appearing.

Now there is one caution, though, and that was brought out on this work, and there has been some work done since then. On the experimental work on that job, the man that is operating that has a great liking for experimental work and is trying everything under the sun. But it stands out that they worked six months on that before the speaker had the pleasure of going to that plant, and three days after we were there we did it, and our company received an order for two full automatics on the strength of it, so that was the proof of the pudding. But he has been experimenting since. This is what we did learn. If you cyanide copper flash work, you must neutralize that in acid before you nickel plate. And I don't mean by neutralizing it just putting it in muriatic acid, for example, and taking it right out again and rinsing it; I mean leaving it in muriatic acid. Every piece of work that we plated, that we just immersed in it, peeled. Those which we left in for a half a minute, the peeling wasn't so bad. Those we left in one minute and a half in the acid, never peeled, and then it was assumed that in practice, where there may be a difference in concentration of acid during a day, the best thing to do was to keep it in two minutes. Those were left in two minutes, did not peel; and pieces were cut out, bent, and they even were made red hot and plunged into cold water, and there was no peeling.

Now, to try to get over that particular point this investigator, and he is very clever, this investigator tried to improve upon that, which all of us should do, no matter who goes into your plant and

does anything—see if you can't improve upon it. That is the only way we learn, and the man that can't stand improvement isn't very much good. To overcome that, he tried acid copper, because he knew if he had alkali copper he might get peeling, and if he had that neutralized that he wouldn't get peeling. And therefore his argument was, "Why not use acid copper?" So he acid copper plated the work and it came up.

Now I learn today from speaking to a good friend, he said that this man has asked what addition agent to use to make the acid copper bright, and the suggestion was to use glue in the solution. Glue was used in the solution, and the work came out bright. Now he wants to know how to control the glue, and that is another story. But it is true that if you copper plate, you get a great deal better results, and that is before nickel plating, not after nickel plating, and you don't have any peeling.

But here is a disadvantage of acid copper. I must caution you on that. It is well known from the work, for example, that was done by Dr. Blum and the work by Dr. Graham, and Blum and Rauden, and Graham, that the crystal structure of the base metal materially influences the crystal structure of the deposit no more in any solution than in acid copper, and if you have some brasses that have a large crystal structure and you put it into acid copper, you may get a reproduction of that crystal in the acid copper film which may give you a peculair crystallized effect under your nickel. So that you must take that into consideration, and if you have that trouble, then you know why it is. Cyanide copper, being of a finer grain, doesn't exhibit that property, and nearly all of you people that oxidize copper brass, you know if you take a piece of brass and put it into an acid copper solution and plate it, it will come out all nice grain structure, very similar to what you get on the crystallized brass finish. But if you cyanide copper flash that, and then put it in your acid copper, you can plate it and it is O. K. So that is a thing you must watch.

Now, in going over that, I will answer my first question. I am giving you this as an opinion, and don't say that I said that—just say I said that is an opinion, and you can try it out in your own plant. It is my opinion that the reason so much nickel peels after it is chromium plated is because there is an alkali film upon the metal before it is put into the nickel solution. It is my opinion that cyanide on brass, before going into a nickel solution, is wrong. I think we ought to use an acid; I think that when any article goes

from a brass solution, from a cleaner, into an acid solution, that it should go in acid. The best experience, the best thing I can give you to show that, is two things. One by Blum, and I think it was Thompson or Thomas—I don't recall which it was—or was it Herring? Dr. Blum can correct me. He found that when he dipped the work in a nickel sulphate solution, took it out of that, and then put it into the regular plating solution, that they had the least amount of porosity. Where they took it from an alkali solution, evidently they had a larger amount but they didn't notice it, when they put it into a nickel solution and took it out. That came in mighty handy to me at one time, plating large copper sheets which are used for washing machines. There was trouble with peeling, trouble with spots, pitting—the whole thing was solved by putting them in a nickel solution previous to the pickel plating solution, and we took advantage of keeping that nickel solution at a PH of 5.2, because that higher acidity more quickly neutralized whatever alkalinity there might be on the work, and when that was carried over into the solution it kept the PH of the larger solution constant, so that we didn't have to correct for the PH in the solution, except probably once a week. And that was a large solution, and that was just using a little common judgment, that is all.

It is my judgment, and you can try it out—it is my judgment that what we must do, to have good, adherent nickel, so you can chromium plate over that, is to have no alkali on the work when it goes into your nickel solution, and no alkali on it at all when it goes into your chromium solution. And that will assist you in overcoming some of the difficulties.

Now the President had said my time is up. Instead of having twenty minutes, and instead of taking Dr. Graham's time, I have taken nearly everybody's time, and I thank you very much.

CHAIRMAN SCOTT: I assure you, Mr. Hogaboom, your time was well spent. We will now go to our next speaker, Dr. Blum.

MR. GEORGE GEHLING: I am sorry we had to stop this interesting Question Box. It is a new innovation here, asking questions without having a set talk, or a set speech, and has proven out very satisfactory. We had to stop that because our time was limited; we have another speaker we want to put on, Dr. Blum, and we know he has some report to make, so I am making this

excuse in regard to cutting the Question Box short on Mr. Hogaboom.

I want to make an announcement that this year you will find, when you get in the banquet room, we have no advertising program, but instead, we are getting out a year book, and the minutes of this meeting this afternoon, and all the discussion, will be printed in that year book. The object of bringing this before you at this time is this. One of our Committee will give each one of you a blank card, and we would like to have you put your name and address on that blank card and give it back to that Committeeman, because we are going to depend on that card to get a copy of this year book to you. We don't want to miss anybody.

In regard to the Quaker City Platers' Reminder, you will notice that it is a new innovation we have gotten out this year for the members of the Philadelphia Branch. I want to apologize to one of the persons here today that gave a paper at the University, because the printer in his hurry so we could have a certain amount of these copies to give to you men here, who wouldn't get it any other way, he misplaced the talk. He has the title page in the back end of the talk instead of the front of it, so I hope you will excuse this little error. So when you read this you will be able to understand the trouble. The printer's devil, as they call him, gets the blame for mixing the plates.

DR. W. BLUM*

Bureau of Standards and Member Balti.-Wash. Branch, Electro Plating Research at Bureau of Standards, Washington, D. C.

DR. WM. BLUM: I don't know whether to consider that being placed at the end of the program is a compliment or not, but I will let you judge afterwards for yourself. At least, I can't help but be reminded of the time when I attended a Chicago banquet. This was before they held the afternoon educational session, and the speeches then were following the banquet in the evening, and I happened to be down as the last speaker. But I also happened to be down to take a train at 11:30, and the result was that it was eleven o'clock when I was called on to speak, and I spoke, I think, for about ten minutes, grabbed my hat and coat, got in a taxi, and got off to the train. About a month later, I met one of the

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*Philadelphia Branch, 1929, Sovenier Sov-year Book.

fellows from Chicago, and he said to me, "Say, Doc, that was the finest talk you ever gave. I hope you always have a train to catch!"

Now there is one difference between this talk that I am going to give you and the one which is reported in the reminder, the Quaker City Reminder, and that is that when you get to the end of the Quaker City Reminder you know what the man was talking about. I am not sure whether you will be able to say that you know what I have been talking about when I am through, or not. As a matter of fact, my talk is a continuation of the Question Box, because I am not going to tell you the answer to these things. If we know the answer, we would be through; But I am going to tell you some of the questions that we are working on at the Bureau of Standards so that you may be better acquainted with the progress which we are making or trying to make.

This resume, then, of the work which is in progress at the Bureau is not intended to be a final report on any except possibly one or two of the subjects, but rather to let you know what we are interested in so that you can inform us and advise us regarding any information that you may have which will assist in these researches.

Now in spite of the fact that everybody is interested in chromium plating today, as we heard in the discussion a few minutes ago—nickel plating in connection with chromium plating has certainly received more importance even than before, and while as also pointed out in the discussion, the PH, the acidity of nickel solutions, or any other single factor, is not sufficient to account for either the pitting or the peeling of nickel plating, it is a factor which must be controlled in order to produce uniform nickel plating. Now of course many of you are familiar with, and have used the Colorimetric method of measuring PH and controlling the solution. Within the past few years there have been two or three persons who have suggested and recommended the use of the Electrometric method, the so-called Quinhydrone electrode, for measuring the PH of the nickel solutions, an apparatus possibly more elaborate than that used for the Colorimetric, but on the other hand, which gives very satisfactory, reproducible results. Now one question that has come up is the fact that sometimes the results obtained by the Colorimetric method and by the Quinhydrone method do not agree. Some persons say they find they do agree; others find they do not agree. In order that we shall

have the facts, and afterwards we can explain them, we are making a co-operative study with four or five laboratories besides our own, in which a whole series of nickel solutions will be measured by these different persons with different indicators and with the Quinhydrone electrode so that we will find out if there is a consistent difference in the results obtained by the different methods. In other words, the thing that I want to emphasize to you platers is this, that we are not satisfied to get a method. That is the first step. Then, afterwards, we have to refine that method, we have to determine whether it is sufficiently accurate for the increased demands that are being made upon it through, for example, the developments in nickel plating.

Another little detail in connection with nickel plating is the specification of nickel salts. We have nothing new to offer on that, but to call your attention to the fact that although heretofore we have just proposed a specification for the use of those in the industry who cared to use it, we are now drawing up and will very soon adopt a specification, a Federal specification, for nickel salts, which will mean that all of the nickel salts used in electro-plating or electro-typing establishments by the Government, that is, of the Government, will conform to this specification, and the interesting thing is that in corresponding both with the manufacturers of nickel salts, and some of the very large users, we have found that except in minor details, the specification which was proposed five years or so ago seems to meet all the requirements. Again, the net result of that is that the manufacturers will automatically tend to bring all of their material up to that standard because they can't afford to make one barrel of salt for Uncle Sam a little purer than the rest of their stuff, and they are going to try to live up to that standard, which I believe most of them are doing at the present time.

We are working on the purification of cyanide in order to make a study of cyanide plating solutions, and feel that after a great many trials in the very difficult process of making an absolutely pure cyanide as a standard, we have succeeded in doing that.

Copper electro-typing solutions may not seem to be of interest to you, but we are working upon the use of addition agents in copper electro-typing solutions, and especially the means of controlling them. Now here is the significant thing, that in connection with electro-plating today, there is no question that acid copper solutions are being used to a far greater extent than they were, for

example, ten years ago, and therefore anything that is learned about copper electro-typing solutions will, with proper adaptation, be useful also to the electro-platers.

We have been doing some work with iron deposition. Again, this may not be of interest to most of the platers. It is information of an electro-forming proposition, but it points out the possibility in case you have a problem of that kind come up. As you all know, we have for several years been carrying out at the Bureau of Engraving and Printing an electrolytic procedure for making the printing plates which are now used for printing over 70 per cent of the paper currency. Now those plates have as the essential part, nickel and copper within a chromium surface. We are experimenting, and I think I can say successfully, upon the production of all iron plates. In other words, deposit a plate a quarter of a inch or a fifth of an inch thick, entirely of iron, and then to put chromium upon that surface. That would have the advantage of not only using a cheaper metal than the nickel and copper, but also the fact that we have a soldering process and several intermediate finishing processes. Those plates are not in production; that is, we are not printing very much money from those iron plates, but the results obtained so far are so promising that we feel reasonably certain we can work out the details so as to put it into actual operation.

I just brought along a few samples of the iron. That (shows) represents a sample of the iron that is cut down to make a test for tensile strength. This other piece (shows) you, as you can tell by putting those two pieces together, that there is a considerable elongation of the specimen in the processes of pulling it, determining the tensile strength. In other words, this iron is a relatively soft, ductile iron. I don't mean it is very soft; it probably is about as hard as the average nickel, and has an elongation of about 20 per cent.

I am going to take a minute to tell you an interesting experience, because it is good just for us all to once in a while recognize our mistakes or oversights, if you choose, and you can judge afterwards whether the joke is on me or on Tom Slattery. I think we both have to share it. He was making these iron plates at the Bureau of Engraving and Printing and getting some excellent results with the flat plates which will represent about a fourth of the production. The question came up, would it be satisfactory to make these flat plates of iron for curved plates. They would have

to be curved after they were made. And since everybody talks about electrolytic iron as being brittle, and since in our first experience the iron, even though it was satisfactory, was somewhat brittle, he, and I as well, naturally thought that we would have to do something to make it soft enough to bend, so he asked if we could make some tests on annealing iron, and he sent these samples out of which the one I showed you is one of the pieces, and we determined the tensile strength, and the elongation of one specimen was determined while we were going ahead with the annealing experiments, and when I got the result that the material had over 20 per cent elongation, it occurred to me that a material that was stretched 20 per cent doesn't have to be annealed in order to bend it around to a curve. So, one of the pieces of iron was lying on my desk, and I took it and bent it around (demonstrates). As you can see, there is no question about it being brittle at all, and the joke was on us. In other words, we were trying to remedy a defect which didn't exist in the material. But it just shows we mustn't take things for granted.

All of us get these old woman's tales, as I call them. In other words, these ideas that somebody handed down from somebody else, and so on, and we believe them instead of taking the time to find out for ourselves whether they are so or not. That is a good lesson for all of us.

On the question of chromium plating, there are lots of unanswered questions, of course, and some of those have come up and have been referred to in the discussion this afternoon. We are trying to fill in the gaps in chromium plating; in other words, to get information on those important points on which there is still uncertainty. One of these is regarding the whole process; in other words, what is the theory of chromium plating? Why is it that you have to have sulphate in there? What is the effect of trivalent chromium, that is, partially reduced chromium or chromium chromate, in the solution? In going at it that way, we are starting out with a study of conductivity, and then will determine the effect of these different things on the conductivity. First of all, of course, we have to know the conductivity of the pure chromic acid, and that means you have to make some pure chromic acid. The chromic acid which is being furnished to the trade today for chromium plating is remarkably pure. I say that without any hesitancy. But at the same time it was necessary to get it down to the highest degree of refinement which has proven to be a quite

troublesome thing. Then we will be ready very soon to measure the conductivity. Because this is a surprising thing that in all of the literature of chemistry, that is, of physical chemistry and conductivity, you can not find any reliable result for the conductivity just of pure chromic acid. Someone called our attention to some results in the literature which we had overlooked. They were buried in a place that we didn't expect them, and when we took those results and compared them with a few other results that we had located, we found they differed by 50 per cent, so that they can't both be right, and we are hoping to find out which is right, and get the facts—so that there is one of the by-products; in other words, we will get a table of the conductivity of pure chromic acid as something to be published in the literature and then we will use that information to see how we can help out with chromium plating.

We have heard a good deal about throwing power in chromium plating, but as far as I know, no actual measurements, quantitative measurements of throwing power in chromium plating have been published, and Mr. Farber, who is research associate of the Electro-Platers, has started this study of throwing power. Here again, it proved difficult, because we had to get a throwing power box—you all remember the hard rubber box I have shown here several times, but hard rubber will not stand up any length of time in the chromic acid, and it was necessary therefore to make a plate glass box without any cement, in other words, a plate glass box which will be tight without seams. We succeeded in doing it, but it was a very troublesome thing to do. Now then, when we started to make the measurements, I was surprised—perfectly frankly disappointed to find how difficult it was to get quantitatively reproducible results with chromium plating. Of course, we can get good plating over a certain range of conditions, but to try to get exactly the same efficiency in repeated experiments, especially at low current density, we found was quite difficult, and it has only been within the last couple of weeks we have got results that we believe are correct, and then we can go on and vary those, and I hope that within a few months we will have some definite information upon throwing power.

I am going to refer to a point which came up in the discussion, even though I can't give an answer to it, and that is that there may have been some confusion in your minds with regard to the effect

of iron, because it is entirely one thing to talk about what the effect of a little bit of iron may be in a solution, and the effect of a large amount of iron in the solution. In other words, we can say without argument that there is ample published evidence to show that large amounts of iron increase the resistivity of the solution, and are therefore detrimental. I do not believe, with all due respect to Mr. Proctor and others, because there are a good many others in the country that have used iron in the solution—I do not believe that there have been any very careful comparable experiments conducted from which you can say whether a very small amount of iron would improve the throwing power, for example, or not. We hope to get results on that which will be conclusive.

We have been making a few experiments which so far or recently have been promising, on chromium plating on aluminum alloys. Now we all know that there is a considerable amount of chromium plated aluminum ware being produced today which is at least fairly satisfactory, which represents nickel plating over aluminum, and then the application of the chromium to the nickel, using the methods of nickel plating that have been developed by Dr. Work with the Aluminum Company. Now the particular problem which we have in mind demands application of a thick coating of chromium, not for ornamental purposes, but for wear resistance. So far, as I say, we haven't the answer to it, but at least we are getting some promising resutls which indicate if we can define the conditions we can get such deposits. Our trouble is we get them sometimes, and sometimes we don't.

One of the most important questions in connection with chromium plating has been the question of the health of the operator. Now a couple of years ago, when the question of the health hazard in chromium plating came up (it may have been in this meeting, for all I know), I rather smiled—I will be perfectly frank, I rather smiled at the idea of platers who handle thousands of gallons of cyanide, talking about anything being poisonous, because I thought that platers were all so hard boiled, or copper plated by this time that there wasn't anything could affect them at all. And you remember the incident about how poisonous cyanides are—the medical student in the examination question said that "Cyanide, or hydro-cyanide, is so poisonous that if you put a drop on a dog's tongue it will kill you in a minute." Chromic acid is not poison in that sense. There is no evidence that chromic acid or chromium compound produce any detrimental effect on the system. I don't

say that they don't, because no one can ever tell what might be discovered from further research, but thus far all the medical literature fails to show any evidence that the chromium compounds produce any effect on the system as a whole. But on the other hand, all of you do know that they go after sores or cuts on the hands and produce very mean sores. You also know that they go after the nasal tissue and produce inflammation, and finally a destruction or perforation of the nasal tissue.

The question came up to us in a way which is very important to you folks and to your employers. It came to us through the State Board of Health, through these Employee's Compensation Boards, because if chromium plating were recognized as a dangerous profession you would soon find that there might be unnecessary precautions thrown around it, that might hinder and hamper the development of chromium plating. We solicited and obtained the adoption of the Public Health Service in determining the effect of chromium compounds on the health of operators, and the investigation, which was brief, consisted in measuring the ventilation in six different chromium plating plants in determining the amount of chromic acid present in the air under definite conditions of ventilation and then examining the workmen to find out which of the men had suffered any injury to the nasal tissue. The results indicate that very low concentrations of chromic acid will, if inhaled continuously, produce injury to the nasal tissue. People who were racking up work, ten or fifteen feet away from the chromium tanks, would just as likely have perforated septum (they didn't know it) as those who are working right over the chromium tanks. In other words, if the ventilation was poor and chromic acid got spread out into the room, it didn't take much of it to do harm. On the other hand, it was perfectly feasible to eliminate the trouble with chromic acid if you have enough ventilation of the right kind. Fortunately, I think we can say that practically all chromium plating plants have adopted what is certainly the best system of ventilation, that is, transverse ventilation. The trouble with putting a hood over a plating tank or cleaning tank or anything of the sort, over which a man has to work, is that you let the man work there and inhale all of the stuff that he can, and then you pull out the rest. Now that isn't doing him any good. So that the only type of ventilation that is effective is to take the fumes out before they get up into the air of the room which it is necessary for the man to breath; and that is being done effec-

tively in every plant, or can be, by very simple modifications. We found that with the ordinary arrangement, a slot anywhere from one to two inches wide running along the edge of the tank, that if you have a velocity of the air of about 2000 feet per minute in that slot, it will remove the chromic acid so completely there will be no injury to the operator, if the tank is not too wide. If your tank is over 18 or 20 inches wide, it is better to have a ventilating duct on both sides of the tank so that you don't give any chance for the gas to go off and get away from the current of air. Or you can put the duct in the center, if you choose, and pull both ways. That is purely a matter of convenience with respect to the type of work to be done. If the men, in addition, will put a little vaseline in their nose occasionally, and on cuts and sores, they will very greatly reduce the danger from chromic acid. If the trouble develops, it is well to have medical treatment immediately, and one of the things which is used in that medical treatment is to put some reducing agent on. You see, chromic acid is a strong oxidizing agent. Therefore if you put a reducing agent on, such as ammonium polish sulphide, any sulphide you use in coloring, on sulphite, or thyol-sulphate, anything which will destroy the chromic acid and prevent it from continuing its attack of the tissues, after which you have the problem of a sore to heal with the proper ointments.

In connection with the chromium plating of plumbing fixtures, the Government of course purchases these materials for new buildings and so forth, and they hesitated to purchase chromium plated fixtures without a specification for them. The difficulty with writing a specification for chromium plated plumbing fixtures is that they have not been in use sufficiently long that we can really say with certainty that fixtures that are plated with a certain thickness of chromium would last so long under certain conditions of service. And therefore we have to guess at it, and, guessing, we naturally want to guess conservatively. In other words, it is better to put on more chromium than is needed in order that chromium doesn't get a black eye in order that you don't have a lot of failures of chromium around in a lot of installations and people say, "We have no more use for chromium plating." And the specification which has been proposed and probably will be adopted is that brass fixtures shall be plated either with chromium directly, with an average of .0002 inch, or with .0002 inch of nickel plus .00002 inch of chromium. In other words, either have a thick deposit of chromium,

or a relatively thick deposit of nickel and a light deposit of chromium. We do not know, from actual experience, which of those will be best. Certainly the thicker deposit of chromium will stand up under the wear and abrasion better. On the other hand, it may be that the deposit having nickel and then a thin deposit of chromium will stand up under tarnish and corrosion better, because we know of course the more layers you have there of metals the less likelihood there is of having porosity all the way through it.

The question came up as to whether chromium plated directly on brass. This was a cast brass, and likely to have these hair line cracks. So far as we know, it may, but a few experiments did not indicate their presence to the same extent as was observed in the work of Baker, who found that if you put more than a certain thickness of chromium on steel, that is, which had been nickel plated, that he got an actual decrease in protective action, because of increased cracking and increased porosity. Now I say that that deserves further study, but so far on a few samples we had plated in a commercial plant, we did not find, for example, by simply taking a fixture—it is easy enough—you take a heavy chromium plated fixture and place it in concentrated nitric acid, and if there are any pores and nitric acid will find them and under those circumstances we did not find in most of the specimens any evidence of this cracking. But a couple of the specimens did. We put them in nitric acid, and they just flaked off, just whole silky flakes of chromium came off, showing perhaps under certain conditions of plating there may be more tendency to that cracking than under others.

An application of chromium plating which is perhaps less conspicuous, certainly less conspicuous than the plating on automobiles, and which you platers may not come in contact so much with is the question of mechanical equipment in other words, dies, gauges, those things which are plated not for appearance, but for purposes of wear. Now here is a difference. I just suggest this to you. If anybody puts chromium plating on automobile, that automobile is bound to cost them a little bit more than if they didn't put the chromium plating on, but if they put chromium plating successfully on gauges and dies, they use in making automobiles, and make those parts last longer, the automobile will cost a little less to make than if they did not use the chromium. In other words, the savings in chromium plating may come from these inconspicuous uses, where the chromium is used for wear resist-

ance. We made a survey recently, of which the results will be reported in detail to a meeting of mechanical engineers the first week in December, and that showed chromium plating is being quite extensively applied, and tried, on various mechanical equipment. The gauges are certainly most satisfactory, plug gauges are very satisfactory, and many plants are using them in regular production now because they find that they last several times as long as the plain steel gauges. On thread gauges, the problem is a little more difficult, but that is a problem for you platers. It is possible, with proper control, to deposit the chromium (of course you can never deposit chromium uniformly on a thread gauge; there is bound to be more at the top of the threads than at the bottom), but with the study of throwing power, and with the best efforts that the platers can use, they make that difference small enough so as not to be outside the tolerance of the gauge. Then the plating will be satisfactory, or may be satisfactory, on the thread gauges.

We find that on dies for stamping sheet metal and so forth that the results are very satisfactory. On moulding dies, for bakelite, for rubber, for various materials of that kind, chromium is being used to a considerable extent, although there again (and I mention this for the benefit of the platers), the man who is interested from the standpoint of production (that is, a plastic material) said they got the most erratic results. One plant would say the chromium plating was good, and another plant would say it was no good. Now, it was perfectly evident that if they were building the same product the plating must have been different under some conditions than under others, so that is a problem the plater has to have in mind.

When we come to stamping dies, where we have very high pressure and impact, the problem is more difficult, because chromium is brittle, and I can say in advance I feel quite certain that if you put much chromium on, it will not be satisfactory. But a light coating of chromium on, for example, a hard steel die, say .0002 inch of chromium, there is good reason to believe will increase the life of the dies. Had you asked me the question, I would have been more skeptical. But the experiments are being made right here in the Philadelphia Mint. You see, this is a money making proposition, this chromium plating, and the first experiments they made, they did not get conclusive results, but within the last few

months they coined some pure nickel coins for South American countries. You see our ordinary American nickels have 25 per cent nickel and 75 per cent copper. These were pure nickel, and they coined some thirteen million of them, and they found that the pure nickel, although apparently not any harder than the other nickels, wore the dies faster than the ordinary ones, and in despair they tried the chromium plating and found the life of the dies was three to four times as long with the chromium plating than without it. So we can say at least in that application, in coining nickel coins, that the chromium plating stood up. But I warn you in advance you will probably get better results with a light coating of chromium where you have a heavy impact like that, than with a heavy coating of chromium.

Another subject I will touch on very briefly, because you will get a more detailed report of it—we have already had some report on the subject of spotting out, which Mr. Barrows, your Research Associate, has been working on at the Bureau of Standards, and I just want to remind you that the evidence shows there are two different types, that which occurs on sulphide finishes, which consist of the growth of small crystals under the lacquer, and that which occurs particularly on cast metals, which is certainly due to the porosity of the metal and the taking up of the solution, the chemicals from the plating and cleaning solutions, in those pores. And then afterwards it comes out and produces a stain. Now all of the evidence shows that in order for it to come out and stain, there must be moisture get in. Therefore, if you keep the moisture out, you will have less tendency for spotting. And the quality of the lacquer has a great deal to do with the penetration by moisture. We found, as has been reported already in the Review, that the phenol condensation lacquers are less porous, less permeable to moisture than are the nitro-cellulose lacquers, which you have commonly used, and are therefore probably better suited for that purpose, but they have to be baked. We are not through with those experiments; we are going to make further experiments—confirmatory—and also just within the last week have invited all the lacquer manufacturers of the country—I'll say we tried to invite all; if we have overlooked any I will ask any of you who find you have been overlooked to write to me, because we want all of the lacquer manufacturers of the country to send in samples so we will find out whether any of the products are essentially different, that is, products of one type—if they are essen-

tially different from others. And that work, when completed, will be published in detail.

Now that covers what we are doing, what we have under way. You notice I haven't given you very much in the way of definite results because those are the questions which we can't answer, but we hope to answer as a result of the research work.

Just what problems will be taken up next will depend upon the wishes and advice of the Research Committee, who in turn are just at the present time asking the manufacturers of the country what they think are the most important problems of plating to take up, and I simply want to tell you that we at the Bureau of Standards want to continue and extend our work as much as possible so as to make it of direct benefit to the platers and to the whole plating industry. I thank you.

CHAIRMAN SCOTT: Are there any questions you would like to ask Dr. Blum?

Well, gentlemen, this has been a very interesting afternoon, and I am sure we are indebted greatly to all the speakers.

This meeting is now adjourned.

PITTSBURGH BRANCH

"The Electrochemists to Discuss Aviation Materials." As many of our members are members of this society, we believe the following will be of interest to them:

The American Electrochemical Society will hold its Fall Convention in Pittsburgh, September 19, 20 and 21, to discuss among other subjects, the contributions of the American Electrochemical Industry to aeronautics. Several hundred chemists, metallurgists, plant executives and company officials of both the United States and Canada, will then convene to discuss recent developments in the Electrochemical Industry.

The program will consist of visit to various industrial plants in the Pittsburgh district, and also technical sessions at which papers on electrochemical subjects will be presented by various prominent men from all over the country. There will be a special symposium on "Contributions of Electrochemistry to Aeronautics," with emphasis given to the light weight Aluminum and Magnesium alloys used in aeroplane construction.

Social features of the meeting will include a smoker, a dinner and dance, and a special program for the ladies of the party.

Pittsburgh, in many ways, can be considered the cradle of the electrochemical industry of the United States. It's the home of aluminum. The bringing of aluminum into the rank of the cheaper metals is looked upon generally as one of the foremost metallurgical achieve-

(Continued on page 38)

A. E. S. PAGE

Assembled Expert Scraps With and Without Significance

They're Both Right

Phone Operator: "That language is entirely uncalled for."

Customer: "So were the last seven numbers you gave me."—*J. Sarnat.*

The Remedy

"I say, old dear, what's good for biting fingernails?"

"Sharp teeth, silly."

The stingy farmer was scoring the hired man for carrying a lighted lantern to call on his best girl.

"The idea!" he exclaimed. "When I was courtin' I never carried no lantern. I went in the dark."

"Yes," said the hired man, sadly, "and just look what you got."—"Ain't so."

Here's health to girl who can
dance like a dream,
And the girl who can
pound the piano;
A health to the girl who
writes verse by the ream,
Or top with high C in so-
prano;
To the girl who can talk and
the girl who does not;
To the saint and the sweet
little sinner;
But here's to the cleverest girl
of the lot—
The girl who can cook a
good dinner.
—(*Editor's Favorite.*)

Do You Know That

About the only time a golfer tells the truth is when he calls another golfer a liar?

* * *

Nowadays whatever is not worth saying is sung?

* * *

You can't be a perfect idiot because nobody is perfect?

The Measure of a Man

Not—"How did he die?"
But—"How did he
live?"
Not—"What did he gain?"
But—"What did he
give?"
These are the units
to measure the worth

A. E. S. PAGE

Of a man, as a man,
Regardless of birth.
Not—"What was his station?"
But—"Had he a heart?"
And—"How did he play,
His God-given part?"
Was—"He ever ready
With a word of good cheer,
To bring back a smile,
To banish a tear?"
Not—"What was his church?"
Not—"What was his creed?"
But—"Had he befriended
Those really in need?"
Not—"What did the sketch
In the newspapers say?"
But—"How many were sorry
When he passed away?"

Yesterday's Tight-Wad

The fellow who was unable to take his girl to the theater. She couldn't find her purse.

Auto-Suggestion

A sore throat is all that keeps some wives from driving the car.

If sulphur products are the cause of spotting out, then the cause of that cause must be our good friend, Wilfred McKeon, who is the father of sulphur products.

Did you notice the number of fellows looking for Dad Liscomb. He gets more popular each year.

H. E. Willmore was a popular guy also.

M. W. McKeon had as a guest Miss Joan Trumbour, assistant advertising manager of Metal Industry, in an airplane flight over city of Detroit. And when you get Joan up in the air that's something.

Geo. B. Hogaboom conversed with Mike, then decided his brass was green enough and quit Mike. Our first Vice-president Van made a bum out of Mike and had lots of voice in reserve.

ments of the nineteenth century, and the historian of technology classes and industrial production of aluminum alongside the invention of Bessemer steel. Charles M. Hall, a chemist, took a metallic rarity and made out of it a common metal, and made the entire human race his debtor. The commercial development of the Hall process was begun in 1888 on Smallman Street, Pittsburgh, Pa., and the manufacture of aluminum became a business success at New Kensington, Pa. Since then the progress has been wonderful, and chemistry has been the pathfinder.

Another example of Pittsburgh's contribution to electro-chemistry is the discovery of silicon carbide (Carborundum) by E. G. Acheson. Acheson first produced carborundum in March, 1891, at Monongahela City, Pa., and began its manufacture in a small way. For the first six months his production amounted to about one-fourth pound per day; but the preliminary manufacturing experimentation proving encouraging, a company was organized, and in 1894 industrial operations were transferred to Niagara Falls. In addition to Aluminum and Carborundum, Pittsburgh is producing chlorine, caustic soda and other sodium compounds, chromium and graphite, is the center of the iron, steel, coal and glass industries of the country, and the home of Station KDKA, the pioneer broadcasting station of the world.

The headquarters of the meeting will be the William Penn Hotel, Fifth Avenue and William Penn Way, in the down-town business section of Pittsburgh. For those who prefer to stay in the Oakland district, which is the educational center of the city, the Schenley Hotel, Webster Hall and the Fairfax Hotel will be very convenient. In this district are situated the University of Pittsburgh, (new skyscraper building under construction,) Mellon Institute of Industrial Research, Carnegie Institute of Technology, Carnegie Library, Bureau of Mines, Forbes Field, the home of the Pirates, Pittsburgh Athletic Association, University Club, Physicians' Building, Research Laboratories of the National Tube Company and the American Sheet and Tin Plate Company, and many other buildings of cultural, social and technical institutes.

While Pittsburgh can accommodate a large number of transients, it is suggested that reservations be made as soon as possible.

APPLICATIONS

	Branch
Frank Schneider	Newark
Wm. F. Fox, 2304 S. 5th St., Rockford, Ill	Chicago
Frank H. Yarke, Box 11, Itasca, Ill	Chicago

ELECTIONS

	Branch
Fred English, 60 Chambers St., Boston, Mass	Boston
Wm. E. Baulien, Jr., 1674 W. Brozel St., Stratford, Conn	Bridgeport
Chas. L. Berry, 415 Cottage Hill, Elmhurst, Ill	Chicago
George E. Stoll, 314 S. 5th St., Goshen, Ind	Chicago
Wm. F. Holzappel, 421 W. Mulberry St., Baltimore, Md	Baltimore-Washington

Clifford R. Prescott, care New Haven Sherardizing Co., Hartford, Conn. ..... Hartford-Connecticut Valley
John Tack, 1485 Woodland Ave., Cote, St. Paul and Montreal, Canada ..... Montreal
F. Daubney, 217 Argle Ave., Ottawa, Ont., Can..... Montreal
Eugene Brennan, 247 Common St., Watertown, Mass..... Boston
Chas. O. Hardy, care Can Fastener Co., 31 Ames St., Cambridge, Mass. ..... Boston
John F. Harney, 446 Tremont St., Boston, Mass..... Boston
Albert E. Howe, 12A Mayer St., Boston, Mass..... Boston
Jos. J. Gorman, 12A Mayer St., Boston, Mass..... Boston
Donald Wood, 384 Boylston St., Boston, Mass..... Boston
Guy Gregory, 150 Causeway St., Boston, Mass..... Boston
Wm. F. Mitchell, 29 Decatur St., Charleston, Mass..... Boston
Daniel P. Mitchell, 158 Chelsea St., Charleston, Mass..... Boston
Eugene Brennan, 247 Common st, Watertown, Mass..... Boston
Ed. T. Ehrhardt, 8 Stetson St, Whitman, Mass..... Boston
D. A. Cotton, 1550 Ohio Ave., Anderson, Ind..... Indianapolis
Hyman Weiman, 648 Mt. Vernon Ave., Detroit, Mich..... Detroit
John Moker, 597 Pacific Ave., Stamford, Conn..... Bridgeport
Wm. F. Bridgett, 286 Ward St., Wallingford, Conn..... Bridgeport
A. Seebahrt, 217 Mansfield Ave., New Haven, Conn..... Bridgeport

REINSTATEMENTS

	Branch
A. M. Kappeler	Chicago
V. J. Huebner	Chicago

RESIGNATIONS

	Branch
Fred P. Burkel, 540 Liberty St., Aurora, Ill	Chicago
J. A. Messick, 185 Woodlawn Terrace, Waterbury, Conn	Waterbury

TRANSFERS

	Branch
C. E. Thornton from Chicago to	Los Angeles
Jas. Corbett, Sr., from Pittsburgh to	Los Angeles
John Merigold from Newark to	Los Angeles
Louis Schulte from Pittsburgh to	Cleveland

SUSPENSIONS

	Branch
Reme Chalut	Montreal
Fred Bezier	Montreal
Geo. E. Warbeck	Toronto
Val Hetzler	Rochester
C. B. Jugle	Rochester
Ed Moulder	Rochester
Mortimer Crumb	Rochester

DEATHS

	Branch
M. Hilliard	Chicago

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Meets in Enoch Pratt Library, Calhoun and Hollins Sts. Geo. F. Turner, Secretary, Baltimore, Md.

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Platers' Supply Co., 202 Friend St., Boston. Secretary, A. W. Garrett, 45 King St., Dorchester, Mass.

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Meets second Friday of each month at Central Y. M. C. A., 16th and Locust St. Secretary, C. T. McGinley, 8214 Fairham Ave., University City, Mo.

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Meets fourth Monday of each month at Canadian Foresters' Hall, 22 College St., Room No. 2. Secretary, H. W. Graham, 26 Beatrice St., Toronto, Canada.

WATERBURY

Meets every second and fourth Thursday of each month. Secretary, Wm. F. Guilfoile, Garden Theatre Bldg., East Main St., Waterbury, Conn.

WORCESTER

Meets Directors' Room, Chamber of Commerce, Worcester, Mass.

1928-1929

Roger H. Bryant, Secretary, 94 Grove St., Worcester, Mass.